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Guidance for the Evaluation of the Erosion Potential of Land Disposal Facility Covers

Soil erosion involves the detachment, transportation, and deposition of soil particles by water or air. These particles collide to displace other soil particles thus increasing the erosive force down the slope, forming rills and gullies. This situation may eventually lead to the successive failure in land disposal facility covers.

The rule, 329 IAC 10-22-7(c)(3) states that the maximum projected erosion rate of the final cover must be no more than five (5) tons per acre per year. The currently accepted methods for determining the projected erosion rate of land disposal facility covers are the Universal Soil Loss Equation (USLE), and Revised Universal Soil Loss Equation (RUSLE).

USLE is an empirical equation and is limited by available research data. In RUSLE, the empirical approach has been combined with the process-based approach with the help of a computer program. These are tools to estimate the rate of soil loss based on site specific conditions and a guide for the selection and design of sediment and erosion control systems for the site. It is important to note that the facility may use either USLE or RUSLE for soil loss calculations, but USLE inputs should not be used in RUSLE and RUSLE inputs should not be used in USLE.

This guideline provides direction for maximizing the accuracy of soil loss estimates at a land disposal facility. The criteria set out in this guideline are intended to promote consistency in calculating soil erosion. The information on USLE can be found in Design and Construction of Covers for Solid Waste Landfills, available from EPA, or in the Agriculture Handbook 537, available from the U.S. Department of Agriculture (USDA), Natural Resources and Conservation Service (NRCS). The information on RUSLE is available in the USDA Agriculture Handbook 703.

The accuracy of a predicted soil loss will depend on how accurately the physical and management conditions on the particular piece of land are described by the parameter values used. *The facility shall submit the list of all related input data and proper justification with the application for review. The justification should include the provisions and maintenance schedules to ensure the attainment of the projected values.*

Equation:

Both USLE and RUSLE, are based on a common mathematical equation that computes a value for the average annual erosion. The RUSLE is the successor to the USLE. The Average Annual Soil Loss equation for both USLE and RUSLE is

A = (R)(K)(LS)(C)(P)

where,

A = Average annual soil loss (tons/acre/year)
R = Rainfall/Runoff erosivity
K = Soil erodibility
LS = Slope length and steepness
C = Cover management
(C factor for land disposal facility covers should be representative of the vegetative cover of the site at the end of the third year of the growing seasons).
P = Support practice

General Description:

USLE:

The *R-Factor* represents the erosive force of rainfall as obtained from Figure 59, page 128 of Design and Construction of Covers for Solid Waste Landfills. This value ranges from 130 to 225, depending on location.

The *K-Factor* ranges from 0.30 to 0.50. The main soil properties affecting K are soil texture, organic matter, structure, and permeability of the soil profile. The facilities may evaluate the site specific soil samples to determine the appropriate K factor. If the soil source or characteristics are unknown, it is recommended that a value of 0.43 should be used for land disposal facility covers.

The *LS-Factor* can be found on Table 28, page 132 of Design and Construction of Covers for Solid Waste Landfills. Provided that the slope segments are of equal length, for a three segment slope, the values from Table 28 can be multiplied for upper, middle and lower segments by 0.58, 1.06 and 1.37, respectively. For two segment slopes, use 0.71 and 1.29. If the slope can not be modeled into two to three equal segments, then the method specified on page 16 of the Agriculture Handbook 537 is recommended.

The *C-Factor* of 0.05 is recommended for most land disposal facility grass cover mixtures. A C-Factor lower than 0.05 will be allowed only with intensive specifications regarding vegetative layer quality, site preparation, fertilization, seeding, and management. A C-Factor lower than 0.01 will only be considered for permanently reinforced vegetation which can be substantiated by

manufacturer or field test documentation.

The base *P-Factor* value for landfills is 1.00.

RUSLE:

The *R-Factor* is contained in the database file provided within the computer program. The site specific files may also be available from USDA, Natural Resources Conservation Service (NRCS).

The *K-Factor* is assigned using a "Soil Erodibility Nomograph" that combines the effects of soil particle size distribution, organic matter content, structure, and permeability of the soil, or surface material. For undisturbed soils, K values are often available from soil surveys conducted by the NRCS. For disturbed soils, the nomograph equations embedded within the program are used to compute appropriate K-values.

The *LS-Factor* combines the effect of the slope length (L) and slope gradient (S) factor. The program has the ability to estimate the soil loss from the combined effects of the non-uniform, complex nature of L and S.

The program uses a subfactor method to compute the *value of "C"*. The subfactors that influence C, change through time, and reflect the changes in soil protection. The program also contains an OPERATIONS database file that characterizes the effects of various soils disturbing activities on soil loss rates. The effectiveness of the cover management subfactors vary with local conditions. Please see Table I for examples of the C factor for various cover types and productivity levels, generated by NRCS. These C factor values are the product of the field data, collected from closed landfills, in Indiana. The facility is required to provide the justification of choosing the specific "C" factor for the facility.

The *P-Factor* accounts for control practices that reduce the erosion potential of the runoff by their influence on drainage patterns, runoff concentration, runoff velocity, and hydraulic forces exerted by runoff on soil. An overall P value is computed as a product of P subfactors for individual support practices, which are typically used in combination.

In RUSLE the user has the flexibility to input values that represent conditions at the specific site. If appropriate values do not already exist in the database, the required input values can be easily obtained from field measurements and then placed in the database.

Table I

RUSLE C Factor Values for Sanitary Landfill Cover

Cover Type	C Factor	Bare Ground	Canopy/Ground Cover	Mulch (4000#)
Grass, high prod	**0.04**	5%	95%	C = **0.035**
Grass, low prod	**0.06**	10%	75%	C = **0.045**
Grass/legume, high	**0.065**	10%	85%	C = **0.055**
Grass/legume, low	**0.10**	20%	65%	C = **0.08**
Grass/weeds, high	**0.11**	30%	70%	C = **0.09**
Grass/weeds, low	**0.20**	55%	45%	C = **0.15**

Notes on Column Headings:

- ***C Factor*** values are to be used in the RUSLE model, version 1.05. Other C factor values may be interpolated to represent other types and amounts of cover or bare soil
- ***Bare Ground*** is the percent of bare ground on the hillslope where the soil loss is being estimated.
- ***Canopy/Ground Cover*** is the percent cover from both canopy cover and ground cover. Canopy cover is defined as leaves and stems that are not in contact with the soil surface during a rainstorm. Ground cover is green vegetation that is in contact with the soil surface during a rainstorm.
- Values in ***Mulch*** column are C factors after straw mulch is added to vegetation described in far-left column of that row. Value represents effect of adding two tons/ac straw mulch.

Notes on Cover Types:

- ***Grass, high prod*** represents primarily grass vegetation, with good vigor or high productivity. Few weeds or legumes present.
- ***Grass, low prod*** represents primarily grass vegetation, with poor vigor or low productivity. Few weeds or legumes present.
- ***Grass/legume, high*** represents a mix of grass and legumes, with good vigor or high productivity. Few weeds present. Root mass less than primarily grass vegetation.
- ***Grass/legume, low*** represents a mix of grass and legumes, with poor vigor or low productivity. Few weeds present. Root mass less than primarily grass vegetation.
- ***Grass/weeds, high*** represents a mix of grass and weeds, with better vigor or higher productivity than described for the same vegetative mix with lower vigor/productivity. Many weeds and much (30%) bare ground. Root mass less than grass and grass/legume vegetation.
- ***Grass/weeds, low*** represents a mix of grass and weeds, with poor vigor or low productivity. Much bare ground (50%) and many weeds mixed with grass vegetation. Root mass lower than other vegetation types described above.

EXAMPLE:

To achieve the 95% canopy cover, either of these two mixes is recommended (by NRCS):

a). Tall Fescue @ 45lbs. Per acre PLS, Perennial Ryegrass @ 5lbs. Per acre PLS*,

or

Orchardgrass @ 25lbs. Per acre PLS, Perennial Ryegrass @ 5 lbs. Per acre PLS.

* PLS=Pure Live Seed

b). Nitrogen applications in the second and third year after the establishment are strongly recommended. The items important for successful seeding establishment listed below should be the minimum, facilities should consider:

I. Species of grass or legumes to be seeded,
II. Seeding rate (pounds per acre) of pure live seed,
III. Fertilizer to be applied at seeding and follow-up applications,
IV. Planned lime application (tons per acre),
V. Planned mulch application (pounds per acre),
VI. Planned seeding period,
VII. Planned cover crop and rate of seeding.

For additional information on the seeding specifications, please contact Mr. Darrell Brown, Conservation Agronomist, NRCS.

References:

1. U.S. Department of Agriculture Handbook 703 and 537
2. mcgregor@sedlab.olemiss.edu
3. Darrell Brown, NRCS.e-mail: darrell.brown@in.usda.gov
4. Glenn Weesies, NRCS.e-mail: Weesies@ecn.purdue.edu
5. Design and Construction of Covers for Solid Waste Landfills, 1979, EPA 6002-79-165 or National Technical Information Service (NTIS), PB80-100381.
6. Indiana's Erosion and Sediment Situation, 1984, Governor's Soil Resource Study Commission

Advanced Design Methods for Selecting Sediment and Erosion Control BMPs, 1996, International Erosion